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# Values Versus Environmental Knowledge as Triggers of a Process of Activation of Personal Norms for Eco-Driving

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## Abstract

Eco-driving can be an effective strategy to save fuel and reduce CO<sub>2</sub> emissions on the road. In the current study, we reason that personal norms are important predictors of eco-driving, and that they are activated when people are aware of environmental problems caused by behavior (problem awareness) and believe that they can contribute to the solution of the problem by changing behavior (outcome efficacy). Extending previous research, we aim at testing two antecedents of this norm activation process: values and environmental knowledge. Results revealed that in comparison with knowledge, values—in particular biospheric values—were strongly associated with the intention to eco-drive by being highly related to awareness of problems caused by car use, which in turn was associated with stronger outcome efficacy beliefs and personal norms for eco-driving. Findings indicate that values are more likely to be a motivational force for pro-environmental intentions than is environmental knowledge.

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**Keywords**

norm activation model, values, environmental knowledge, eco-driving, personal norm

**Introduction**

High emissions of carbon dioxide (CO<sub>2</sub>) is the leading cause of global warming (Wengraf, 2012). Transport is among the most significant contributor to increased CO<sub>2</sub> emissions (Chaari & Ballot, 2012; ECMT, 2007; Wengraf, 2012). Emissions of CO<sub>2</sub> resulting from car use pose a serious threat to the environment. Moreover, car use causes local air pollution and deteriorates water and air quality. Such problems could be reduced by reducing car use, or by promoting a fuel-efficient driving style, labeled as eco-driving. In the current article, we focus on eco-driving. Eco-driving is broadly defined as employing certain behaviors and techniques that would reduce fuel consumption (Wengraf, 2012). These could be behaviors that are directly related to adopting an eco-driving style, such as avoiding abrupt accelerations and decelerations, appropriate shifting of gears, maintaining the same speed and avoiding high speeds, as well as the maintenance behaviors such as checking tire pressure on a regular basis or not using the air conditioning of the vehicle (Barkenbus, 2010; Cristea, Paran, & Delhomme, 2012; Greene, 2008; Schall & Mohnen, 2015; Sivak & Schoettle, 2012). As these behaviors need to be learned before being implemented, much attention has been paid to the development of eco-driving training, incorporating these into novice driver training, and testing the effectiveness of these training programs in reducing fuel consumption (CIECA, 2007). Studies testing the effectiveness of such training programs reveal that up to 10% of fuel can be saved simply by employing eco-driving, indicating that adopting an eco-driving style is related to decrements in fuel consumption and, therefore, CO<sub>2</sub> emissions and pollutants (Barkenbus, 2010; CIECA, 2007; Jeffreys, Graves, & Roth, *in press*; Wengraf, 2012).

However, some drivers like to drive fast (Elander, West, & French, 1993; Jonah, 1986), which might contrast with eco-driving actions. Therefore, eco-driving might require a change from one's preferred way of driving. As the monetary gains resulting from reduced fuel use are rather small, and eco-driving might not be seen as highly convenient, pleasurable, or profitable, people may be reluctant to implement it (Delhomme, Cristea, & Paran, 2013; Harvey, Thorpe, & Fairchild, 2013; Schall & Mohnen, 2015). This may explain why the effect of eco-driving training seems to vanish in the long run, and drivers seem to fall back into their original style of driving (af Wahlberg,

2007), indicating that training does not necessarily predict long-term changes in fuel-efficient driving behavior. Hence, just teaching people how to engage in eco-driving seems to be insufficient, and motivational factors, in particular, may be key to promote eco-driving. Investigating psychological factors that are likely to predict stable intentions would reveal more about which factors motivate people to drive in a fuel-efficient way.

Various studies have looked at potential factors motivating people to engage in eco-driving behavior and intention, such as money or fuel saving, financial rewards, reducing air pollution, increasing driving safety, and reducing noise on the road (Cristea et al., 2012; Dogan, Bolderdijk, & Steg, 2014; Lai, 2015; Lauper, Moser, Fischer, Matthies, & Kaufmann-Hayoz, 2015). Findings indicate that receiving financial rewards in exchange for saving fuel might motivate (professional) drivers to practice eco-driving (Lai, 2015), but it is not known whether drivers would continue practicing eco-driving in the long run if the financial reward were removed. Indeed, when drivers are externally motivated to practice eco-driving due to financial rewards, they might easily fall back into their initial driving behavior when such financial incentive is not present (Bolderdijk, Knockaert, Steg, & Verhoef, 2011). In addition, research showed that drivers might not always be motivated to change their driving behavior into eco-driving for financial gains, as drivers do not always think small financial gains are “worth-the-effort” (Dogan et al., 2014). Interestingly, though, drivers seem to think that small environmental gains (such as CO<sub>2</sub> emission reductions) are more meaningful and worth the effort, which might enhance their motivation to practice eco-driving for environmental reasons (Dogan et al., 2014). Such findings indicate that normative considerations, such as protecting the environment, might be an important driver of eco-driving intention.

Factors that motivate people to engage in sustainable travel or driving behavior have been examined by focusing on different processes, including intentional (e.g., theory of planned behavior; Ajzen, 1991), habitual, and normative processes (see Klöckner & Blöbaum, 2010). Moral or normative considerations are important in predicting intention to engage in pro-environmental behaviors that have no immediate benefits for the individual (Steg, Bolderdijk, Keizer, & Perlaviciute, 2014). In such cases, people act in an environmentally friendly way because they feel benefitting the environment is the right thing to do. Normative considerations might be potentially relevant for eco-driving: People may mostly engage in eco-driving even if it is not pleasurable because they care about the environment. In this article, we examine to what extent and via which processes moral considerations promote eco-driving. This has not been tested before.

More specifically, we test the norm activation model (NAM; Schwartz, 1977). The NAM posits that people will engage in pro-environmental behaviors when they feel morally obliged to do so, as reflected in strong personal norms (PN). For instance, when one holds strong personal norms to eco-drive, one would be more likely to engage in eco-driving and refrain from actions that would compromise driving in a fuel-efficient way. According to the NAM, personal norms are activated when people are highly aware of the negative consequences of not behaving in an environmentally friendly way (problem awareness [PA]), and when they think that by changing their actions, they can reduce their negative impact on the environment (outcome efficacy [OE]). Following this reasoning, the more people are aware of environmental problems resulting from car use, the more they think they can help to solve these problems by adopting eco-driving, which enhances their feeling of moral obligation to do so, in turn encouraging actual engagement in eco-driving.

The NAM has been tested for various pro-environmental behaviors, and findings provided support for the causal chain of the process of norm activation triggered by PA (De Groot & Steg, 2009; De Groot, Steg, & Dicke, 2007; Guagnano, Dietz, & Stern, 1994; Nordlund & Garvill, 2002; Steg & De Groot, 2010). An important question is which factors affect PA. On one hand, PA may depend on motivational factors, notably what people generally deem important in life (Steg, Bolderdijk et al., 2014; Stern, 2000). As such, values might be particularly important antecedents of PA, and act as general motivating factors triggering the process of activation of personal norms (Steg et al., 2014; Thøgersen & Ölander, 2002). On the other hand, research suggests that PA may be higher among people who are knowledgeable about causes and consequences of environmental problems (Bord, O'Connor, & Fisher, 2000; O'Connor, Bord, & Fisher, 1999). In the current study, we aim to compare the predictive power of knowledge and values and examine which one of the two is more likely to trigger a process of activation of personal norms by increasing people's PA, in turn increasing intention to eco-drive. Below, we will first outline which types of values and knowledge might be relevant in this respect, before discussing the current study.

## Values

Values are defined as general goals that people strive for in life (Schwartz, 1992, 1994). Values define what people find important, and how they perceive and evaluate options (Feather, 1995; Steg, Perlaviciute, van der Werff, & Lurvink, 2014). As such, values can predict a wide range of behaviors, including pro-environmental actions. The value-belief-norm (VBN) theory

(Stern, Dietz, Abel, Guagnano, & Kalof, 1999; see also Stern, 2000) extends the NAM with values, and proposes a causal chain where values would affect PA, which then would have an effect on OE beliefs, followed by personal norms and finally environmental intentions and behaviors (Stern, 2000). Notably, VBN theory proposes that the extent to which people endorse different values could trigger or inhibit activation of personal norms (Steg et al., 2014; Stern et al., 1999). Three types of values have been proposed to be relevant in this respect: biospheric, altruistic, and egoistic values (De Groot & Steg, 2007, 2008; Stern, 2000; Stern & Dietz, 1994). Biospheric values represent a key concern for the environment, whereas altruistic values represent a key concern for the welfare of others. Both biospheric and altruistic values are likely to enhance PA as they put emphasis on collective benefits, including nature and the environment, and of other people, respectively. Egoistic values, however, represent a key concern for maximizing individual benefits and minimizing individual costs (Steg, Bolderdijk et al., 2014), which is likely to reduce PA as many pro-environmental actions imply some personal costs. As such, they are likely to inhibit the process of norm activation.

Various studies have provided empirical support for the VBN theory. Notably, in line with VBN theory, research has identified biospheric and altruistic values as being positively related to PA, OE beliefs and personal norms, as well as to pro-environmental intentions and behaviors in various domains, including transport (De Groot & Steg, 2008; De Groot, Steg, Keizer, Farsang, & Watt, 2012; Jakovcevic & Steg, 2013; Nordlund & Garvill, 2003; Steg, Dreijerink, & Abrahamse, 2005; Stern, 2000), meaning that biospheric and altruistic values could indeed trigger the process of norm activation. In contrast, egoistic values were either negatively related or unrelated to PA, OE beliefs, personal norms, and environmental intentions and behaviors (De Groot & Steg, 2008; De Groot et al., 2007; Jakovcevic & Steg, 2013; Stern, 2000; Stern, Dietz, Kalof, & Guagnano, 1995; Thøgersen & Ölander, 2002), meaning that egoistic values do not trigger or even inhibit the process of norm activation. These findings indicate that values might indeed act as distal predictors of pro-environmental behaviors via a process of activation of personal norms. Are values the most important predictors of the norm activation process? Could knowledge also fuel this process?

## ***Knowledge***

Lack of environmental knowledge has been considered to be an important factor that might prevent people from accepting relevant mitigation policies and to adopt pro-environmental actions (Bord et al., 2000; Stern, 1992). For

instance, it has been argued that if people do not know that CO<sub>2</sub> emissions are the main causes of global warming, they will not be aware of the need to do something about it, and not attempt to reduce their impact on the environment by changing their behavior (Kaiser & Fuhrer, 2003). Although there is some evidence to suggest that knowledge may enhance concern and awareness for environmental problems (Shi, Visschers, & Siegrist, 2015; Tobler, Visschers, & Siegrist, 2012), research has not tested yet whether knowledge would indeed trigger a process of norm activation as proposed by the NAM, thereby making people feel personally and morally obligated to act pro-environmentally by enhancing PA and OE. In addition, research has not tested which type of knowledge would be more relevant in this respect. For instance, in predicting intention to eco-drive via a process of norm activation, should one focus on general knowledge about the causes or consequences of climate change, or on more specific knowledge of environmental problems resulting from car use? Scholars have proposed that general knowledge about causes and consequences of environmental problems, such as climate change, may predict pro-environmental beliefs and intentions (Frick, Kaiser, & Wilson, 2004; Kaiser & Fuhrer, 2003; Shi et al., 2015; Tobler et al., 2012). As such, general knowledge about causes and consequences of environmental problems might indeed fuel a process of norm activation and strengthen pro-environmental intentions.

Apart from general knowledge of causes and consequences of environmental problems, specific knowledge on the negative consequences of a particular behavior may be a relevant knowledge factor. Specific knowledge, which has been labeled as concrete knowledge, action-related knowledge, or procedural knowledge, represents knowledge on the causes and consequences of environmental problems related to the targeted behavior, and of actions that may reduce these problems (Kaiser & Fuhrer, 2003; Schahn & Holtzer, 1990; Shi et al., 2015; Sia, Hungerford, & Tomera, 1986). For instance, in the case of eco-driving, specific knowledge might cover causes and consequences of environmental problems resulting from car use, as well as knowledge of driving-related actions that might be taken to reduce these problems, such as eco-driving. Some have argued that specific knowledge might be more predictive of PA and pro-environmental actions than knowledge about general causes and consequences of environmental problems, by being more compatible with and related to the target behavior (Kaiser & Fuhrer, 2003; Schahn & Holtzer, 1990; Shi et al., 2015; Sia et al., 1986). We will study to what extent general knowledge about causes and consequences of global warming and specific knowledge about environmental problems caused by car use predict PA and elicit a process of activation of personal norms.

## **Current Study**

In the current study, we will test which factors trigger norm activation, and compare the VBN theory with an alternative route to norm activation with knowledge, which we label as the knowledge–belief–norm (KBN) theory. Notably, we aim at investigating whether values or environmental knowledge would enhance PA, thereby eliciting the process of activation of personal norms. Following the VBN theory, we will include three value types: biospheric, altruistic, and egoistic values (Steg, Bolderdijk et al., 2014; Stern, 2000). In addition, we will include three knowledge types: general knowledge of the causes of global warming, general knowledge of the consequences of global warming, and specific knowledge of CO<sub>2</sub> emissions and particulate matter resulting from car use.

## **Method**

### ***Participants and Procedure***

Data collection was carried out door to door in three different neighborhoods in the north of the Netherlands. To guarantee a varied sample, we selected one neighborhood with relatively affluent residents and one with relatively less affluent residents in a city, and a third neighborhood in a village. People were asked whether they would be willing to participate in a study about their driving behavior, and that filling in the questionnaire would take approximately 20 min. If the person agreed to participate, the researchers made an appointment with the participant to pick up the questionnaire about 30 min later. Eighty-three respondents participated in the questionnaire study; data of two respondents were excluded from the analyses because of an abundance of missing data. We detected single-cell missing data in biospheric values (two cases), altruistic values (one case), egoistic values (one case), PA (four cases), and intention to eco-drive (one case), which were handled by using mean replacement. The sample was not entirely representative of the Dutch population, as a small majority were male (58%). Mean age of participants was 48.51 years ( $SD = 12.63$  years). More than half of the participants either held a university degree (25%) or a higher vocational education degree (35%). The other participants held an intermediate vocational education degree (31%), vocational degree (9%), or basic education (1%). About 62% of the participants were frequent car users, meaning they reported using the car always or most of the time as compared with other modes of transport. The other participants were less frequent users of the car, meaning they indicated using the car only sometimes and interchanging with other modes.



Participants first filled in the knowledge and values scales followed by responding to the items of the NAM and intention to eco-drive. The questionnaire included some additional items on knowledge, responsibility, and sustainable mobility that were not relevant for the study, and therefore, are not reported here.

## Measures

**Values.** We used a brief value questionnaire developed by De Groot and Steg (2008). The scale consisted of 13 items depicting egoistic, altruistic, and biospheric values. Participants indicated the importance of each value to them as a guiding principle in life ranging from  $-1$  (*opposed to my values*),  $0$  (*not important*), to  $7$  (*of supreme importance*). Egoistic values were measured with five items: that is, social power, wealth, authority, influential, and ambitious ( $\alpha = .67$ ;  $M = 2.40$ ,  $SD = 1.08$ ). Altruistic values were measured with four items: that is, equality, a world at peace, social justice, and helpful ( $\alpha = .69$ ;  $M = 5.27$ ,  $SD = 0.92$ ). Four biospheric values were included: that is, respecting the earth, unity with nature, protecting the environment, and preventing pollution ( $\alpha = .88$ ;  $M = 4.81$ ,  $SD = 1.21$ ).

**Knowledge.** We measured three different types of environmental knowledge as described below, reflecting environmental facts and common misconceptions that have been identified based on previous literature (Bord, Fisher, & O'Connor, 1998; Bord et al., 2000; Chapman, 2007; Dunlap, 1998; Frick et al., 2004; Stamm, Clark, & Reynolds Eblacas, 2000). Items reflecting each type of knowledge were presented in a mixed order. Participants responded by using a 3-point scale:  $1 = \text{correct}$ ,  $2 = \text{not correct}$ ,  $3 = \text{I have no idea}$ . Participants were prompted to use the last option in case they were not sure about the answer. With that, our aim was to prevent participants from guessing the answers. We calculated the total number of items in each subscale where participants got the right answer, to be used in further analyses (see Table 1 for an overview of responses including the percentage of correct responses for knowledge questions).

The first subscale measured general knowledge of the causes of global warming. The scale is comprised of five items: (a) The cutting of trees enhances global warming, (b) intensive pig farms contribute to global warming, (c) methane emissions by car use contribute to global warming, (d)  $\text{CO}_2$  emissions have the biggest contribution to global warming, and (e) the use of fossil fuels, such as oil, coal, and gas, contributes to global warming. We counted the number of correct answers; mean score for this subscale was  $3.42$  ( $SD = 1.16$ ).

**Table 1.** Percentages of Correctly and Incorrectly Given Responses on Knowledge Statements.

	Correct	Incorrect	No idea	Missing
<b>General knowledge of causes of global warming</b>				
1. The cutting of trees enhances global warming	81.5	11.1	6.2	1.2
2. Intensive pig farms contribute to global warming	72.8	4.9	21	1.2
3. Methane emissions by car use contribute to global warming	34.6	17.3	46.9	1.2
4. CO <sub>2</sub> emissions have the biggest contribution to global warming	65.4	9.9	23.5	1.2
5. The use of fossil fuels, such as oil, coal, and gas, contributes to global warming	87.7	1.2	9.9	1.2
<b>General knowledge of consequences of global warming</b>				
1. According to most scientists, greenhouse gas emissions by humans lead to climate change	85.2	8.6	3.7	2.5
2. Global warming leads to floods	74.1	13.6	11.1	1.2
3. According to most of the scientists, global warming leads to extreme weather conditions	72.8	14.8	9.9	2.5
4. Global warming leads to the extinction of species	76.5	7.4	14.8	1.2
5. Deserts get bigger as a consequence of global warming	55.6	18.5	24.7	1.2
6. Global warming leads to the formation of holes in the ozone <sup>a</sup>	21	67.9	11.1	-
7. Acid rain is a direct consequence of the greenhouse effect <sup>a</sup>	35.8	55.6	7.4	1.2
<b>Specific knowledge of CO<sub>2</sub> emissions and particulate matter resulting from car use</b>				
1. Old generation cars have higher CO <sub>2</sub> emissions than the same type of new generation cars	88.9	4.9	3.7	2.5
2. Particulate filters reduce CO <sub>2</sub> emission by cars <sup>a</sup>	69.1	17.3	11.1	2.5
3. Cars that run on biofuels emit no CO <sub>2</sub>	58	14.8	24.7	2.5
4. Driving 2 times with the car means 2 times more CO <sub>2</sub> emissions <sup>a</sup>	71.6	12.3	14.8	1.2
5. The weight of the car does not matter for the amount of CO <sub>2</sub> that the car emits <sup>a</sup>	34.6	60.5	3.7	1.2
6. In general, diesel cars emit less particulate matter than benzene cars <sup>a</sup>	71.6	11.1	17.3	—

<sup>a</sup>Indicates that the statement is false, and therefore, a correct response on these statements would be to indicate that it is a false statement.

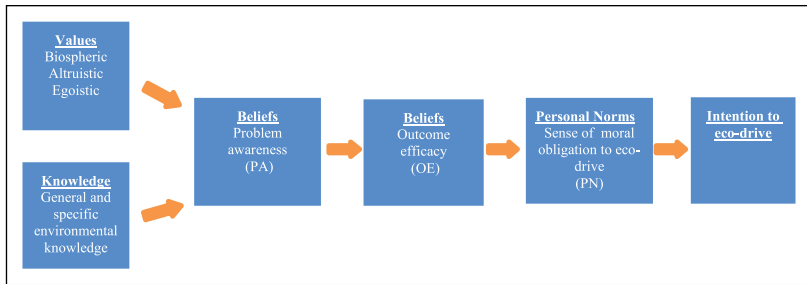
The second subscale measured general knowledge of the consequences of global warming. The scale comprised seven items: (a) According to most scientists, greenhouse gas emissions by humans lead to climate change; (b) global warming leads to floods; (c) according to most scientists, global warming leads to extreme weather conditions; (d) global warming leads to the extinction of species; (e) deserts get bigger as a consequence of global warming; (f) global warming leads to the formation of holes in the ozone; and (g) acid rain is a direct consequence of the greenhouse effect. We again counted the number of correct items; mean score for this subscale was 4.21 ( $SD = 1.56$ ).

The third subscale measured specific knowledge of CO<sub>2</sub> emissions and particulate matter resulting from car use. The scale is comprised of six items: (a) Old generation cars have higher CO<sub>2</sub> emissions than the same type of new generation cars, (b) particulate filters reduce CO<sub>2</sub> emission by cars, (c) cars that run on biofuels emit no CO<sub>2</sub>, (d) driving two times with the car means two times more CO<sub>2</sub> emissions, (e) the weight of the car does not matter for the amount of CO<sub>2</sub> a car emits, and (f) in general, diesel cars emit less particulate matter than benzene cars. Again, the number of correct answers was counted; mean score for this subscale was 3.94 ( $SD = 1.48$ ).

**NAM variables.** Based on previous research (De Groot et al., 2008; Eriksson, Garvill, & Nordlund, 2006), we included 13 items aimed to measure the NAM variables: PArelated to car use, OE, and personal norms (PN) related to eco-driving. The items were presented in mixed order. Participants indicated to what extent they agree or disagree with each item on a 7-point Likert-type scale (1 = *fully disagree*, 7 = *fully agree*).

PA was measured with seven items: (a) The greenhouse effect resulting from road traffic is a serious problem, (b) air pollution resulting from car traffic is a serious problem, (c) the CO<sub>2</sub> emissions resulting from road traffic is a serious problem, (d) the emission of particulate matter by motor vehicles is a serious problem, (e) I am concerned about global warming resulting from road traffic, (f) I am concerned about the emissions of particulate matter resulting from road traffic, and (g) I am concerned about CO<sub>2</sub> emissions resulting from road traffic. The Cronbach's alpha of the scale was  $\alpha = .91$  ( $M = 4.65$ ,  $SD = 1.01$ ).

OE regarding eco-driving was measured with four items: (a) It is worthwhile to drive fuel efficiently to reduce CO<sub>2</sub> emissions, (b) it is worthwhile to drive fuel efficiently to reduce the emissions of particulate matter, (c) it is worthwhile to drive fuel efficiently to reduce the greenhouse effect, (d) it is worthwhile to drive fuel efficiently to reduce air pollution. The Cronbach's



**Figure 1.** The chain model in the VBN theory and KBN theory.

Note. VBN = value-belief-norm; KBN = knowledge-belief-norm.

alpha of the scale was  $\alpha = .75$  ( $M = 5.20$ ,  $SD = 1.02$ ). A higher mean indicated a higher OE.

PN regarding driving in a fuel-efficient way was measured with two items: (1) I feel morally obliged to follow the maximum speed limit as much as possible and (b) I feel morally obliged to drive in a fuel-efficient way. The two items were significantly positively correlated ( $r = .45$ ,  $n = 81$ ,  $p < .001$ ). We computed a mean score of the two items; a higher mean indicates stronger PN ( $M = 4.86$ ,  $SD = 1.52$ ).

## Dependent Measures

**Intention to eco-drive.** We measured one's intention to drive in an eco-friendly way with three items reflecting one's motivation and willingness to perform eco-driving: (a) I intend to follow the maximum speed limit as much as possible, (b) I intend to switch to a higher gear as soon as possible, and (c) I intend to drive more fuel efficiently (Ajzen, 1991);  $\alpha = .78$ ;  $M = 5.33$ ,  $SD = 1.22$ . The higher the mean, the higher one's intention is to eco-drive.

**Data analyses.** We carried out a series of regression analyses to test the causal chain in the NAM, and to test whether values or knowledge would better trigger the process of activation of PN (see Figure 1). In these analyses, each time we first tested whether the variable that preceded the dependent variable in the chain directly explained the variance in the dependent variable (i.e., Step 1). In the next step, we tested whether the inclusion of all the other variables further down the chain would improve the explained variance in the dependent variable (i.e., Step 2). Following this procedure allowed us to disentangle whether variables further down the chain have a direct effect on the

dependent variable as well after controlling for the effects of the intermediate variables (see De Groot et al., 2007).

## Results

Prior to testing the models, we first inspected the correlations between all variables (see Table 2). All variables correlated in the expected direction. Findings revealed strong positive correlations between biospheric values, the variables of the NAM, and intention to eco-drive. A similar pattern was observed for altruistic values, although the correlations were weaker. Egoistic values did not correlate significantly with any of the dependent variables. Furthermore, the three knowledge factors positively correlated with each other. Knowledge of general causes of global warming was positively correlated with OE and intention to eco-drive, but the latter correlation was only marginally significant. Knowledge of general consequences of global warming positively correlated with PA as well as with intention to eco-drive. Specific knowledge of CO<sub>2</sub> emissions and particulate matter resulting from car use did not correlate significantly with any of the dependent variables. As expected, there were strong positive correlations between the NAM variables and intention to eco-drive.

### *Predicting Intention to Eco-Drive by a Process of Value-Triggered Activation of Personal Norms*

We first tested whether intention to eco-drive would be predicted by value-triggered norm activation, by carrying out a series of regression analyses (see Table 3). In the first regression analysis, intention to eco-drive was the dependent variable. PN<sup>1</sup> explained 47% of the variance in intention in the first step. As expected, stronger personal norms were related to stronger intention to eco-drive ( $\beta = .69, p < .001$ ). When all the other variables were entered in the regression model in the second step, the explained variance increased to 51%. PN remained as the strongest predictor of intention ( $\beta = .61, p < .001$ ). In addition, OE ( $\beta = .28, p < .01$ ) significantly predicted intention to eco-drive: Higher OE was related to a stronger intention to eco-drive. PA, egoistic, altruistic, and biospheric values did not contribute to the model significantly.

Next, we tested the causal relationship in the NAM by using PN as the dependent variable in the regression analysis. OE explained 17% of the variance in PN at the first step. A high OE was associated with a stronger PN to eco-drive ( $\beta = .42, p < .001$ ). Inclusion of the other variables in the analysis resulted in an increase in explained variance to 29%. At this step, OE was no longer a significant predictor. Biospheric values appeared as the best and

**Table 2.** Correlations Between Variables.

	1	2	3	4	5	6	7	8	9
1. General knowledge—causes	1.00								
2. Specific knowledge	<b>.38***</b>								
3. General knowledge—consequences	<b>.36**</b>	<b>.39***</b>							
4. Egoistic	-.03	.18	.09						
5. Altruistic	.13	-.16	.07	.001					
6. Biospheric	.10	-.09	-.02	.06	<b>.65***</b>				
7. Problem awareness	.15	.02	<b>.28*</b>	-.10	<b>.37**</b>	<b>.57***</b>			
8. Outcome efficacy	<b>.25*</b>	.18	.13	-.03	<b>.37**</b>	<b>.58***</b>	<b>.50***</b>		
9. Personal norm	.02	.01	.15	-.11	<b>.26*</b>	<b>.51***</b>	<b>.46***</b>	<b>.42***</b>	
10. Intention	.19 <sup>a</sup>	.14	.25*	-.10	<b>.29**</b>	<b>.44***</b>	<b>.32**</b>	<b>.50***</b>	<b>.69***</b>

Note. General knowledge—causes indicates "general knowledge of causes of global warming." Specific knowledge indicates "specific knowledge of CO<sub>2</sub> emissions and particulate matter resulting from car use." General knowledge—consequences indicates "general knowledge of consequences of global warming."

<sup>a</sup>Marginally significant at  $p = .08$ .

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

**Table 3.** Multiple Regression Analyses Testing Whether Intention to Eco-Drive Would Be Predicted by a Process of Value-Triggered Norm Activation.

	$\beta$	$t$	Adjusted $R^2$	$F$	$df$	$p$
DV: Intention to eco-drive						
Step 1			.47	72.15	1, 79	.000
PN (eco-driving)	.69***	8.49				
Step 2			.51	14.58	5, 74	.000
PN (eco-driving)	.61***	6.34				
OE (eco-driving)	.28**	2.74				
PA (car use)	-.12	-1.17				
Egoistic	-.03	-0.41				
Altruistic	.08	0.80				
Biospheric	-.02	-0.11				
DV: PN (eco-driving)						
Step 1			.17	17.32	1, 79	.000
OE (eco-driving)	.42***	4.16				
Step 2			.29	7.44	4, 75	.000
OE (eco-driving)	.13	1.09				
PA (car use)	.19	1.61				
Egoistic	-.11	-1.19				
Altruistic	-.13	-1.01				
Biospheric	.41**	2.70				
DV: OE (eco-driving)						
Step 1			.24	26.72	1, 79	.000
PA (car use)	.50***	5.17				
Step 2			.35	11.86	3, 76	.000
PA (car use)	.25*	2.24				
Egoistic	-.03	-0.35				
Altruistic	-.02	-0.18				
Biospheric	.46**	3.40				
DV: PA (car use)						
Step 1			.31	13.16	3, 77	.000
Egoistic	-.13	-1.44				
Altruistic	-.01	-0.07				
Biospheric	.58***	4.76				

Note. PN = personal norms; OE = outcome efficacy; PA = problem awareness; DV = dependent variable.

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

only significant predictor of PN ( $\beta = .41, p < .01$ ): Stronger biospheric values were associated with stronger PN. PA and egoistic and altruistic values did not contribute significantly to the model.

In the third regression analysis, OE was the dependent variable. PA explained 24% of the variance in OE in the first step. A higher PA was associated with a higher OE ( $\beta = .50, p < .001$ ). Inclusion of the remaining variables increased the explained variance to 35% in the second step. At this step, the predictive power of PA decreased ( $\beta = .25, p < .05$ ), whereas biospheric values appeared as the best predictor of OE ( $\beta = .46, p < .01$ ): Stronger biospheric values were associated with a higher OE. Egoistic and altruistic values did not contribute to the model significantly.

In the last regression analysis, values explained 31% of the variance in PA. Only biospheric values appeared to be a significant predictor of PA related to car use ( $\beta = .58, p < .001$ ). A strong endorsement of biospheric values was associated with a strong PA regarding car use.

### *Predicting Intention to Eco-Drive by a Process of Knowledge-Triggered Activation of Personal Norms*

In the second set of regression analyses, we tested whether knowledge triggered the process of norm activation to eco-drive (see Table 4). As the results with direct predictors are the same as in the previous analyses, here, we will only present the findings of the steps in which all other variables were included in the regression analyses.

In the first regression analysis predicting intention to eco-drive, 53% of the variance was explained by OE, PA, and the three types of knowledge along with PN. Personal norms were still the strongest predictor of intention at this step ( $\beta = .62, p < .001$ ). In addition, OE ( $\beta = .27, p < .01$ ) significantly predicted intention to eco-drive: Higher OE was associated with a stronger intention to eco-drive. Neither PA nor the three types of knowledge contributed to the model significantly.

We then tested whether PN would be predicted by all variables included in the model. The proportion of variance explained in PN increased to 23% by the inclusion of PA and the three knowledge types along with OE. OE still predicted PN at this step, although to a smaller extent ( $\beta = .30, p < .05$ ). PA predicted PN as well ( $\beta = .30, p < .05$ ): Higher PA was associated with stronger PN. The three types of knowledge did not contribute to the model significantly.

In the third regression analysis, including the three knowledge types along with PA did not lead to a substantial increase in the proportion of variance explained (i.e., 27%). At this step, the predictive power of PA remained similar ( $\beta = .51, p < .001$ ). The three types of knowledge did not contribute to the model significantly.



**Table 4.** Multiple Regression Analyses Testing Whether Intention to Eco-Drive Would Be Predicted by a Process of Knowledge-Triggered Norm Activation.

	B	t	Adjusted R <sup>2</sup>	F	df	p
DV: Intention to eco-drive						
Step 1						
PN (eco-driving)	<b>.69***</b>	8.49	<b>.47</b>	72.15	1, 79	.000
Step 2						
PN (eco-driving)	<b>.62***</b>	6.94	<b>.53</b>	16.17	5, 74	.000
OE (eco-driving)	<b>.27**</b>	2.79				
PA (car use)	-.15	-1.50				
General knowledge of causes of global warming	.09	1.07				
General knowledge of consequences of global warming	.13	1.45				
Specific knowledge of CO <sub>2</sub> emissions and particulate matter resulting from car use	.00	-0.004				
DV: PN (eco-driving)						
Step 1						
OE (eco-driving)	<b>.42***</b>	4.16	<b>.17</b>	17.32	1, 79	.000
Step 2						
OE (eco-driving)	<b>.30*</b>	2.51	<b>.23</b>	5.67	4, 75	.000
PA (car use)	<b>.30*</b>	2.53				
General knowledge of causes of global warming	-.12	-1.06				
General knowledge of consequences of global warming	.08	0.73				
Specific knowledge of CO <sub>2</sub> emissions and particulate matter resulting from car use	-.04	-0.33				
DV: OE (eco-driving)						
Step 1						
PA (car use)	<b>.50***</b>	5.17	<b>.24</b>	26.72	1, 79	.000
Step 2						
PA (car use)	<b>.51***</b>	5.09	<b>.27</b>	8.39	3, 76	.000
General knowledge of causes of global warming	.16	1.46				
General knowledge of consequences of global warming	-.13	-1.16				
Specific knowledge of CO <sub>2</sub> emissions and particulate matter resulting from car use	.16	1.44				
DV: PA (car use)						
Step 1						
General knowledge of causes of global warming	.10	0.79	<b>.06</b>	2.61	3, 77	.06
General knowledge of consequences of global warming	<b>.29*</b>	2.40				
Specific knowledge of CO <sub>2</sub> emissions and particulate matter resulting from car use	-.13	-1.03				

Note: PN = personal norms; OE = outcome efficacy; PA = problem awareness, DV = dependent variable.  
\**p* < .05. \*\**p* < .01. \*\*\**p* < .001.

In the last regression analysis, PA was entered as the dependent variable and the three types of knowledge were entered as predictors.<sup>2</sup> The regression model was only marginally significant, and the three types of knowledge explained only 6% of the variance in PA. Although the model was only marginally significant, we still inspected which of the three types of knowledge factors would predict PA best. Only the knowledge of consequences of global warming significantly predicted PA ( $\beta = .29, p < .05$ ).

## Discussion

In the current study, we examined whether values versus environmental knowledge would most strongly enhance awareness of the problems resulting from car use, thereby triggering the process of activation of personal norms to engage in eco-driving. For this purpose, we compared the VBN theory with the KBN theory. Our findings revealed that values seem to be a stronger trigger of norm activation of personal norms and intention to eco-drive than is knowledge. More specifically, values were significantly related to PA, and explained a relatively high proportion of the variance in PA. Among the three values, biospheric values appeared to be the single most effective predictor of PA: A higher endorsement of biospheric values was associated with a higher awareness of problems resulting from car use. These findings are in line with previous research that tested the VBN theory in the domain of pro-environmental intentions and behaviors (De Groot & Steg, 2007; Jakovcevic & Steg, 2013; Nordlund & Garvill, 2002, 2003; Stern et al., 1999).

In contrast, environmental knowledge types were not significantly related to PA. We still explored the individual contribution of the different types of knowledge in predicting PA. Only general knowledge of the consequences of global warming was significantly related to PA: Knowing about the consequences of global warming was weakly positively associated with awareness of environmental problems resulting from car use. This suggests that to be concerned about environmental problems caused by car use, one might need to have some general knowledge about the causes and consequences of global warming. This finding is in line with results of earlier studies that suggest that more general knowledge of causes and consequences of environmental problems is associated with higher environmental concern and awareness (Shi et al., 2015; Tobler et al., 2012). However, the finding should be interpreted with care as the regression model was not statistically significant, and only the Knowledge of Consequences of Global Warming subscale showed a weak association with PA.

Interestingly, specific knowledge of CO<sub>2</sub> emissions and particulate matter resulting from car use that is more compatible with the target behavior was

not a better predictor of awareness of problems caused by car use than was general knowledge. In fact, specific knowledge was not significantly related to awareness of problems caused by car use. Similar findings have been reported earlier, where higher knowledge of a specific environmental problem was not significantly associated with higher awareness of that problem and higher engagement in related pro-environmental behavior (Bolderdijk, Gorsira, Keizer, & Steg, 2013; Tobler et al., 2012). Notably, it has been argued that although being compatible with behavior, specific knowledge may not gain motivational force if people do not consider solving the problem an important goal or personal value (Ajzen, Joyce, Sheikh, & Cote, 2011; Bolderdijk et al., 2013). In line with this argument, a recent meta-analysis revealed that climate change beliefs are less strongly associated with knowledge than with motivational factors such as values or worldviews (Hornsey, Harris, Bain, & Fielding, 2016). This may explain why values are more predictive of PA and behavior than is knowledge.

Our research has important theoretical implications. The findings suggest that motivation, in particular the extent to which people endorse biospheric values, plays a more important role in the activation of personal norms than knowledge about environmental problems and, more specifically, problems resulting from car use and possible ways to mitigate these. Notably, biospheric values seem to motivate people to consider the consequences of their actions for the environment and possible solutions to reduce their negative impact on the environment, and to do the morally right thing for the environment. As mentioned above, knowledge seems to fall short in elevating such motivational states to make people feel morally obliged to act pro-environmentally and to strengthen pro-environmental intentions. Future research could examine the conditions under which knowledge may predict relevant beliefs and activate personal norms. For example, research suggests that environmental knowledge might motivate people to act pro-environmentally when they strongly endorse biospheric values (Bolderdijk et al., 2013), indicating knowledge itself might not be sufficient to motivate people to act pro-environmentally.

Moreover, our findings provide empirical support for the NAM: Stronger PA was related to stronger feelings of OE. Next, stronger feelings of OE were related to holding stronger personal norms to eco-drive, which in turn was strongly related to intention to eco-drive. Supporting the VBN theory and NAM, personal norms were indeed the strongest direct predictors of intention, pointing to the importance of moral considerations in pro-environmental intentions related to car use. More specifically, when personal norms are activated, people feel moral obligation to act in line with these norms, even if the behavior would not bring them immediate benefits and pleasure or would

be somewhat costly and effortful (Schwartz, 1973), such as in the case of eco-driving.

Our findings also provided support for the VBN theory. More specifically, people who strongly endorse biospheric values are more aware of the problems caused by car use, which in turn elicited the process of activation of personal norms. Interestingly, results showed that biospheric values were related to variables further down the chain of the VBN theory, such as OE and personal norms, even when intermediate variables were controlled for. Stronger endorsement of biospheric values was related to stronger feelings of OE, and biospheric values more strongly predicted OE than did PA. Similarly, a stronger endorsement of biospheric values resulted in holding stronger personal norms to eco-drive, and biospheric values were more predictive of personal norms than is OE. Similar findings have been reported earlier (De Groot et al., 2007), suggesting that variables further up the chain might directly be related to variables further down the chain as well. The findings point to the motivational force of biospheric values to trigger a process of activation of personal norms. Yet, as we followed a correlational design, inferences about causal relationships between the model variables cannot be made.

Future research could employ longitudinal or experimental study designs that would provide more insight in the causal relationships between values, knowledge, PA, OE, personal norms and eco-driving intention. For example, researchers could study whether providing knowledge or strengthening biospheric values would result in changes in PA, OE, and eco-driving intention. Future studies could also examine to what extent other theories are effective in understanding pro-environmental intentions and behavior such as eco-driving, including models that focus on intentional, affective, situational, and/or habitual factors (e.g., Klöckner & Blöbaum, 2010; Slovic, Finucane, Peters, & MacGregor, 2002; Steg, 2016).

Our findings also have important practical implications. First, findings suggest that interventions that aim at improving environmental knowledge, for example, via information campaigns, might not be sufficient to encourage pro-environmental actions, including eco-driving. Such information campaigns might fall short on raising awareness and concern about environmental problems caused by car use. Our findings point out that biospheric values act as general factors motivating pro-environmental behaviors. As such, informational interventions could emphasize the environmental consequences of the targeted behaviors. For instance, in the case of eco-driving, not merely the financial gains but the environmental gains of eco-driving could be emphasized so that people realize that engaging in eco-driving would support their biospheric values.

Second, much attention has been paid to incorporating eco-driving into novice driver training or developing eco-driving training for professional drivers, with the idea that when people know and learn how to eco-drive, they are more likely to implement it (CIECA, 2007; Strömberg & Karlsson, 2013). As far as eco-driving requires a change in one's driving style and learning about specific skills to reduce fuel consumption while driving, such training programs may be indeed needed. Yet, various studies point out that the effectiveness of such training programs might be short lived, and people may not prioritize eco-driving goals in the face of competing goals, such as safety or time saving (af Wahlberg, 2007; Delhomme et al., 2013; Dogan et al., 2014; Harvey et al., 2013). Our findings suggest that strong biospheric values, PA, OE, and personal norms promoted intention to eco-drive. As such, interventions to encourage eco-driving could not only focus on skill training but also particularly target motivation to protect nature and the environment (i.e., biospheric values), awareness of problems caused by car use, perceived efficacy to help reduce these problems, and feelings of moral obligation to eco-drive. For example, commitment strategies can be used to strengthen personal norms (Steg, 2016): Drivers could be asked to commit to a particular eco-driving goal, thereby fueling feelings of moral obligation to act in line with their commitment. In addition, feedback strategies might help strengthen PA and OE (see Steg, 2016). Thanks to advanced in-vehicle feedback systems, drivers are now able to receive instant feedback on their fuel consumption via dashboard devices (Barkenbus, 2010; Beusen et al., 2009). Also, environmental consequences of one's driving behavior might be emphasized by providing drivers with instant feedback while driving. Such feedback might help drivers in translating eco-driving intention into behavior by constantly reminding people about their eco-driving goals (strengthening personal norms), and inform them about their progress in realizing these goals (strengthening OE), which might be effective to prevent drivers abandoning this goal (Lauper et al., 2015). Third, making people focus on the environment might encourage pro-environmental behaviors, even among those with relatively weak biospheric values (Ruepert, 2016). For instance, it has been found that employees with relatively weak biospheric values are more likely to act pro-environmentally at work when they believed that their organization is committed to corporate environmental responsibility, which makes them focus on the environment (Ruepert, 2016). It is an interesting question whether eco-driving will be promoted as well when contextual factors make people focus on the environment.

In our study, we measured intention to eco-drive by focusing on three specific eco-driving behaviors: following the speed limits, switching to a

higher gear as soon as possible, and driving fuel efficiently in general. In addition, we measured personal norms to eco-drive with two items: one focusing on fuel efficiency and one focusing on following the speed limits. As eco-driving comprises a range of other actions such as checking the tire pressure regularly or avoiding abrupt accelerations or decelerations, future studies could aim at more extensive measures of intention and personal norms, covering different aspects of eco-driving, which could help to further increase the reliability of measures and to cross-validate findings. Furthermore, future research could investigate to what extent eco-driving intention would translate into actual eco-driving behaviors. As car-driving is a rather automated process for many drivers, changing habitual ways of driving into eco-driving might not be easy despite a strong motivation and intention to do so. Making eco-driving a part of conventional driver training, in which motivation to eco-drive is also targeted, might be effective to make eco-driving the habitual driving style from early onward. Yet, to target behavior change in more experienced drivers, future research might aim at disentangling how to break driving habits and replace these with eco-driving practices, for example, by means of (environmental) feedback, which might act as a constant reminder of one's motivation and intention to eco-drive (see Lauper et al., 2015).

To summarize, the current study provides empirical support to the VBN theory and not the KBN theory. Notably, our findings suggest that endorsement of biospheric values was associated with higher awareness of environmental problems resulting from car use. A higher PA was related to a stronger belief that one can contribute to the solution of these problems (i.e., OE). In turn, stronger OE was associated with stronger personal norms to engage in eco-driving, which was related to a stronger intention to eco-drive. As such, biospheric values elicit a process of activating personal norms by being strongly related to PA. Our findings suggest that motivation is an important factor in the face of adopting an eco-driving style, and that values are more likely to encourage people to engage in eco-driving than is environmental knowledge.

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## Notes

1. As the correlation between the two PN items was somewhat lower to form a scale (i.e.,  $r = .45$ ), we also ran the regression analyses by using the PN items separately as single items. The overall interpretation of the findings does not change with the use of single items rather than the PN scale. As such, we report the analyses with the PN scale here.
2. As the knowledge factors were correlated, we also ran the regression analyses by including these separately. The results were very similar to when all three knowledge factors were used at the same time. For ease of comparison between the value-belief-norm (VBN) and knowledge-belief-norm (KBN) models, we report the analyses where all three knowledge factors were entered at the same time.

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